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UTILITY APPLICATION FOR UNITED STATES PATENT

FOR

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The present invention relates to the field of screw terminals, i.e. screws that serve to conduct electricity.

More precisely, the present invention relates to the field of screws designed to provide intermittent electrical contact in the ignition circuit of an internal combustion engine.

Originally, the screws for this application were made of a uniform material, e.g. entirely out of copper, brass, or steel.

Nevertheless, in recent years, the specifications required of screw terminals have become more severe. Thus, they are now required to withstand electrical contact and sparking better so as to guarantee a reduced degree of wear when subject to electric arcing. They are also required to be stronger so as to enable them to be tightened to higher levels of torque than in the past. Finally, they are generally also required to pass higher electric currents, and thus to conduct electricity better.

As a result, people skilled in the art have recently proposed screws made of two materials, i.e. screws in which the main body is made of steel, but having a hollow head suitable for soldering a silver/tungsten alloy pellet which is soldered to the head.

Technically, such two-material screws based on steel carrying a soldered silver/tungsten pellet give satisfaction.

Nevertheless, such screws raise a major difficulty in that they are expensive. This cost is due, amongst other things, to the cost of silver/tungsten: the raw material cost is very high and it is necessary to manage two components: firstly the steel bodies and secondly the silver/tungsten pellets, and this also results in an assembly process.

An object of the present invention is to provide a novel screw terminal suitable for satisfying very severe specifications, and at acceptable cost.

In particular, the present invention proposes a screw terminal satisfying the following specifications:

· strength greater than 580 megapascals (MPa);

· conductivity greater than 25% IACS (International Annealed Cooper Standard); and

· tightening torque greater than 15 Newton-meters (Nm).

The above objects are achieved in the context of the present invention by a one-piece screw terminal characterized by the fact that it is made of a copper alloy based on Cu, Ni, and Si.

According to an advantageous characteristic of the present invention, the screw terminal is made using an alloy comprising about 97% copper, 2% to 5% nickel, typically 2.5%, and 0.3% to 1% silicon, typically 0.5%.

Other characteristics, objects, and advantages of the present invention appear on reading the following detailed description with reference to the accompanying drawing given by way of non-limiting example and in which the sole accompanying figure is a diagram of a screw in accordance with the present invention.

The screw terminal 10 in accordance with the present invention is a single formed piece of uniform material based on an alloy of copper, nickel, and silicon.

More precisely, as mentioned above, the screw 10 in accordance with the present invention is preferably based on an alloy comprising about 97% copper, 2% to 5% nickel, typically 2.5%, and 0.3% to 1% silicon, typically 0.5%.

Preferably, in the context of the present invention, the screw 10 is made from a round wire of constant circular section which is forged cold, e.g. using two strokes.

After this conventional manufacturing process, the screw is preferably subjected to heat treatment for a

period of two hours at a temperature of about 475°C, followed by quenching in water.

A priori, the inventors have found that no special finishing is required.

The general shape of the screw terminal in accordance with a particular and non-limiting embodiment of the present invention is described below.

The screw comprises a threaded body 12 centered on an axis 14.

Typically, but in non-limiting manner, the threaded body or shank 12 has a length of about 30 millimeters (mm) to 35 mm, and a diameter of about 8 mm.

The shank or body 12 may be adapted to be engaged directly in a tapped bore. Nevertheless, in most applications of screw terminals in an ignition circuit of an internal combustion engine, the screw is held in place by means of a nut engaged on the end of the threaded shank 12.

The screw 10 also has a flared head 16 of right section that is not circularly symmetrical so as to perform an anti-rotation function, e.g. by being engaged in a complementary socket formed in the cover of the contactor.

The head 16 may present a right section having a variety of shapes, for example, square, hexagonal, or any other equivalent shape that is not circularly symmetrical.

The dimensions of the head 16 may vary widely. Typically, the head 16 possesses height of about 5 mm (measured parallel to the axis 14) and has dimensions of about 13 mm × 10 mm for a head of rectangular section.

The top surface 18 of the head 16, i.e. the surface perpendicular to the axis 14 and that performs the electrical contacting function, is preferably plane, without any forging seams or flash. It is important for it not to present any concave shape. Thus, it may be

slightly rounded in shape so long as it is convex. It is also smooth.

The edges of the head 16, both those parallel to the axis 14 and those perpendicular thereto, are preferably rounded to have a mean radius of about 0.40 mm to 0.50 mm.

As mentioned above, the screw terminal 10 of the present invention is preferably made from round wire.

The method of manufacturing the screw terminal 10 in accordance with the present invention essentially comprises three stages.

The first stage consists in wire-drawing a round wire unreeled from a supply reel in order to obtain the desired diameter and strength.

This step is typically performed, in a particular and non-limiting implementation, so as to obtain a wire satisfying the following characteristics:

· diameter 7.5 mm for a final screw having a diameter of 8 mm;

· breaking stress R: 320 MPa to 400 MPa;

· 0.2% elastic limit E: 290 MPa to 380 MPa;

· elongation: 10% to 20%;

· Vickers harness on the HV10 scale: 105 to 125.

The second step consists in forging the wire to obtain the shape desired for the screw and to work-harden it. This is preferably done by cold forging, e.g. using two strokes.

The third step consists in performing heat treatment to obtain appropriate strength and electrical conductivity.

Preferably, the heat treatment is performed by maintaining a temperature of about 475°C for two hours, i.e. maintaining the parts at constant temperature, followed by rapid cooling in air, or oil, and preferably in water.

Where appropriate, the parts may be subjected to cleaning before they are used.

The Applicant has found that screw terminals made with the shape, alloy, and method as specified above present characteristics that are better than those of the screws presently available in the state of the art.

Naturally, the present invention is not limited to the particular embodiments described above, but extends to any variant within the spirit of the invention.